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WHO'S DOING WHAT IN CROP BIOTECH :

Selected examples of new biotech applications in field-testing, or awaiting approval for field testing

Crop	Trait	Benefits to: **F**armers, **C**onsumers, **E**nvironment, **H**ealth, **I**ndustry	Organization
Argentina			
Alfalfa	Veterinary active proteins for control of foot-and-mouth disease	**F, C**: The only effective treatment for foot and mouth disease at present is to destroy the animals	INTA (Argentine national public research organization)
Tobacco	Reduced nicotine	**C**: Less addictive	Vector Argentina (private)
Australia			
Grapes	Color, sugar, and tannin metabolism	**C**: Better quality for fresh fruit and wine	CSIRO Plant Industry (public)
Lupins	Sulfer-containing amino acids	**F**: Better feed quality for animals	Uni. Western Australia (public)
Cotton	Oleic acid content	**C, H**: Better human nutrition	Commonwealth Science and Industry Research Organization (CSIRO) (public)
Papaya	Delayed ripening	**C, F**: Less waste, lower prices for consumers	Uni. of Queensland (public)
Brazil			
Beans	Virus resistance	**F, C, E**: Reduced use of insecticides against virus vector, reduced cost to farmers, increased safety for small farmers and consumers –esp. important in countries where training and compliance with pesticide safety regulations is irregular, better food and nutrition security for remote areas	EMPRAPA (Brazilian national public research institute)
Papaya	Virus resistance	**C**: Similar to above. Papaya an essential vitamin source in remote impoversished areas.	EMPRAPA (public)
Bulgaria			
Tobacco	Bacterial resistance, virus resistance	**F, E**: Reduced use of pesticides, safer and less costly cultivation practices for farmers (relevant for production for smoking or future pharma-nutraceutical production)	Inst. of Genetic Engineering, Kostinbrod (public)
Canada			
Alfalfa (Lucerne)	Flavonoid production	**H, C**: Human nutritional value	Ag Canada (public)
Barley	Nutritional value	**F**: For animal feed value	Plant Biotech Inst. NRC (public)
Cherry	Fruit quality	**C**: Value for consumers	Ag Canada (public)
Flax	Oil quality	**H, C**: Better nutritional value for consumers	Uni. Saskatchewan (public)
Oilseed rape	Novel oil qualities	**H, C, I**: Better nutritional value (some novel oil types); industrial uses (other types)	Saskatchewan Wheat Pool (public)

Spruce	Insect resistance	**F**: Reduce losses, protect forest resources	Laurentian Forestry Center (public)
China			
Cabbage, peanuts, wheat	Virus resistance	**F, E:** Reduced use of insecticide against insect vectors	Public sector
Rice	Salt tolerance	**C, E**: Protect supply of critical world crop	Public sector
Cuba			
Banana, papaya, potato	Resistance to pests	Food security where inputs are absent	Inst. de Biotecnologia de las Plantas, Villa Clara (public)
Egypt			
Cucumber	Virus resistance	**F, C, E**: Reduced use of insecticides to control vectors; safer, less costly production for farmers, safer product for consumers	Agricultural Genetic Engineering Research Institute (AGERI) (public)
France			
Lettuce	Virus resistance	**F, C, E**: Reduced use of insecticides against virus vector	INRA (French national public research institute)-Avignon
Maize and tobacco	Human lactoferrin Human collagen Rabies virus G glycoprotein, Superoxidedismutase	**C, H:** Lower cost source of several compounds that: strengthen human immune system; enhance skin health and beauty; protect against fatal disease; protect against aging and cancer. Compounds produced in plants may also be more effective than those produced using present methods.	Biocem-Limagrain (private) Mersitem Therapeutics (private) Biocem-Limagrain (private) Coop de Pau (private) (i.e., several different enterprises)
Oilseed rape	Better retention of ripe seed on plant	**E, F**: Biocontainment of volunteer plants; reduced harvest losses.	Biogemma-Limagrain (private)
Poplar trees	Novel lignin contents (higher, lower)	**C, E:** Stronger wood; paper production with less water pollution	INRA (public)
Germany			
Apple	Resistant to fungi and bacteria (fire blight)	**F, C**: Only present treatment for fire blight is to destroy trees or treat with streptomycin, a clinically - important antibiotic	Bundesanstalt fuer Zuechtungsforschung und Kulturpflanzen, Sachsen-Anhalt (public)
Populars	Heavy metal removal	**E, H**: Bio-remediation of polluted old industrial sites ("brownfields")	Uni. Freiburg
Potato	Spider silk (elastin)	**C**, **I**: Strongest natural fiber known, production from spiders not feasible	Institut fuer Pflanzengenetik und Kulturpflanzenforschung, Gattersleben (public)
Oilseed rape	Novel oil composition for: nutritive value (some varieties); industrial uses (other varieties)	**C, H, I**: Nutrition: prevention of cancer and aging Industrial uses: replacements for petroleum-based products	Institut fuer Pflanzengenetik und Kulturpflanzenforschung, Gattersleben (public) Deutsche Saatveredelung (private) Norddeutsche Planzenzucht Lembke (private) (i.e., several different enterprises)

Hungary			
Wheat	Bread baking quality	**E, F, C:** Genetic diversity: Biotech method to retain classical bread making quality during normal crossing program would allow incorporation of more genetic diversity into the cultivated wheat crop Faster development of new wheat varieties to meet changes in pathogens and climate	MTA Mezoegazdis'ge Kutato' Inte'zete (Martonva'sa'r) (public?)
Italy			
Olive Kiwi Strawberry Tomato	Seedless fruits; ability to set fruits without fertilization	**F, C:** Convenience for consumers and processors; More reliable fruit production in variable weather reduces farmers' risk	Uni. degli Studi della Tuscia, Sez. Ortofloarboricoltura (public)
Eggplant (Aubergine)	Insect resistance, virus resistance, seedless fruits	**F, C:** Reduced use of pesticides, reduced production costs	Ist. Sperimentale per l'Orticoltura (public) (all traits); Metapontum Agrobios Srl (private) (insect and virus resistance only)
African cape marigold	Virus resistance	**F, C:** Reduced pesticide use, lower costs for farmers and flower-lovers	Ist. Sperimentale per la Floricoltura (public)
Japan			
Chrysanthemem	Viroid resistance	**F, E, E:** Reduce use of insecticide to control vector; reduced price for consumer, longer perennial plant life for gardeners	Kirim Brewery (private)
Cucumber, strawberry	Fungus resistance	**C, H, F, E:** Safer produce for consumers, free of mycotoxins (potent cancer-inducing compounds produced by fungi in and on many fruits, vegetables, and cereals). Reduced use of pesticides, reduced production costs	National Inst. Agrobiological Resources (public) Nara Agricultural Experiment Station (public)
Rice	Low protein	**C:** Better for sake brewing	Japan Tobacco Inc (private)
Mexico			
Potato	Virus resistance	**F, C, E:** Reduced use of insecticides to control vector; safer, lower cost production for farmers	CINVESTAV – IPN and INIFAP-SAGAR (public)
Netherlands			
African violet, Carnation	Longer vase life, fungus resistance (carnation); new colors (both)	**C, F:** New products, longer-lasting products for consumers, lower cost and safer production	Florigene Europe (private) Hilverda BV (private) P. Kooij & Zonen BV (private) Van Staaveren (private) StaWest Carnation Group BV (private) (i.e., several different enterprises)

Potato	Resistant to blackspot and bruising	**C, F:** More attractive product for consumer; longer keeping quality	Uni. Wageningen (public) Coop. Telersvereiniging voor de Afzet van Landbouwproducten de ZPC, BA(private) Kweekbedrijf Repta ZPC vof (private) Hettema Zonen Kweekbedrijf PBV (private) (i.e., several different enterprises)
Spain			
Cantaloupe melon	Virus resistance	**F, E:** Reduced pesticide use, safety and lower costs	Te'zier – Limagrain (private) S + G Semillas (private) Seminis Iberica SA (private) (i.e., several different enterprises)
Plum	Virus resistance	**F, C:** "Sharka" or "plum pox" virus. No present treatment except to destroy the trees	Inst. Valenciano de Investigactiones Agrarias (public)
Wheat	Nitrogen use efficiency	**F, E:** Reduced fertilizer requirements; protects water quality	Inst. de Recerca i Tecnologia Agroalimentaries (IRTA) , Catalun~a, Barcelona (public)
South Africa			
Strawberry	Stilbene resveratrol	**C:** Heart-healthy compound (also found in red wine)	ARC Infrutec (public)
Sweden			
Apple	Better rooting ability	**F:** Stress resistance	Swedish Uni. Agricultural Sciences (public)
Potato	Increased starch content	**C, H :** Lower fat absorption during frying; lower calorie fried potato products	Plant Science Sweden AB and Amylogene HB (both private) (joint project)
United Kingdom			
Barley	Improved malting quality	**C, F:** Better beer, more consistent prices for farmers	John Innes Center (public)
Potato	Resistance to nematodes	**E, F:** Reduced need for soil-penetrating pesticides (toxic and atmosphere-damaging)	National Institute of Agricultural Botany (public)
Oilseed rape	Increased lauric acid content	**C, H:** Anti-microbial and anti-viral properties in human diet (i.e. those living with HIV). Cleansers, food processing.	John H. King + Sons Ltd. (private) CPB Twyford Ltd. (private) Scottish Agricultural College, Aberdeen (public) Plant Breeding International (private) (i.e., several different enterprises)
United States			
Banana	Fungus resistant	**F:** Black sigatoka, spreading internationally, small farmers cannot afford fungicides	DNA Plant Technology Inc. (private)
Coffee	Caffeine reduced	**H, C:** Health benefits for consumers	Uni. Hawaii (public)
Chestnut (N. American)	Fungus resistant	**E:** Rescue a near-extinct native hardwood tree	New York State Univ. (public)
Cucumber	Salt tolerant	**E, F, C:** Reclaim over-irrigated lands, anticipate climate change and water shortages	Michigan State Univ. (public)

Maize	Low phytate, more digestible phosphorus content	**E, F:** Protect water quality near animal feeding operations, higher nutritional value of maize for animals	Pioneer (private)
Oats	Virus resistance	**F, E:** Improve financial value of oats as rotation crop	Iowa State Univ. (public)
Potato	Reduced anti-nutritional factors	**F:** Improved animal feed quality; better market for potatoes rejected by food-potato buyers due to cosmetic damage; reduced farmers' economic risk	USDA/ARS (public)
Oilseed rape	Heavy metal remediation	**E:** Bio-(Phyto-)remediation of polluted sites, old industrial or mining sites	USDA/ARS (public)
Rhododendron	Fungus resistant	**C, E:** Root rots: Protect homeowners' investment in popular shrub, reduce garden pesticide use.	Univ. of Connecticut (public)
Rose	Fungus resistant	**C, E:** Black spot: reduce garden pesticide use; safer for home gardeners; extend roses to humid climates	Scotts (private)

This list is not exhaustive. For more information see : http://lbioptech.frc.it/deliberate/gmo.asp; www.nbiap.vt.edu; www.aphis.usda.gov; China: Huang et al, Science 295:674-677(2002); Cuba: www.cuab.cu/ciencias